EXAMINED.

UNITED STATES DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN

WASHINGTON, D. C. 681 JULY 14, 1915.

IMP. BUR. OCT. 1915 ENTOM.

Contribution from the Bureau of Entomology, L. O. Howard, Chief.

THE SILVERFISH;[1] AN INJURIOUS HOUSEHOLD INSECT.

By C. L. MARLATT,
Entomologist and Acting Chief in Absence of Chief.

INTRODUCTION.

The silverfish (fig. 1) is often one of the most troublesome enemies of books, papers, card labels in museums, and starched clothing, and occasionally of stored food substances. Its peculiar fishlike form and scaly, glistening body, together with its very rapid movements and active efforts at concealment whenever it is uncovered, have attached considerable popular interest to it and have resulted in its receiving a number of more or less descriptive popular names, such as silverfish, silver louse, silver witch, sugarfish, etc. The species named above is the common one in England, but it also occurs in this country, and, like most other domestic insects, it is now practically cosmopolitan. It has a number of near allies, which closely resemble it, both in appearance and habits. One of these, (*Lepisma*) *Thermobia domestica* Pack., has certain peculiarities of habit which will be referred to later. The unusual appearance of the common silverfish early drew attention to it, and a fairly accurate description of it, given in a little work published in London in 1665 by the Royal Society, is interesting enough to reproduce:

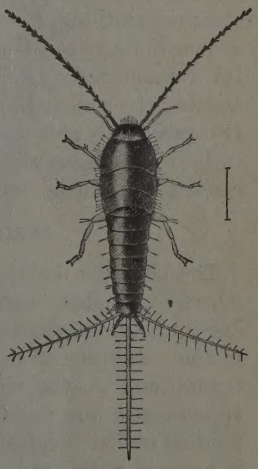

FIG. 1.—The silverfish (*Lepisma saccharina*): Adult. Enlarged. (Original.)

It is a very small, silvery, shining worm or moth which I found much conversant among books and papers, and is supposed to be that which corrodes and eats holes

[1] *Lepisma saccharina* L. Thysanura, family Lepismatidæ.

NOTE.—This bulletin is of special interest to housekeepers throughout the United States. It is a revision of Circular No. 49 of the Bureau of Entomology, U. S. Department of Agriculture.

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through the leaves and covers. It appears to the naked eye a small, glittering, pearl-colored moth, which upon the removing of books and papers in the summer, is often observed very nimbly to scud and pack away to some lurking cranny where it may better protect itself from any appearing dangers. Its head appears big and blunt, and its body tapers from it toward the tail, smaller and smaller, being shaped almost like a carret.[1]

HABITS AND INJURY.

On account of its always shunning the light and its ability to run very rapidly to places of concealment, it is not often seen and is most difficult to capture, and being clothed with smooth, glistening scales, it will slip from between the fingers and is almost impossible to secure without crushing or damaging. It is one of the most serious pests in libraries, particularly to the binding of books, and will frequently eat off the gold lettering to get at the paste beneath, or, as reported by the late P. R. Uhler, of Baltimore, often gnaws off white slips glued on the backs of books. Heavily glazed paper seems very attractive to this insect, and it has frequently happened that the labels in museum collections have been disfigured or destroyed by it, the glazed surface having been entirely eaten off. In some cases books printed on heavily sized paper will have the surface of the leaves a good deal scraped, leaving only the portions covered by the ink. It will also eat any starched clothing, linen, or curtains, and has been known to do very serious damage to silks which had probably been stiffened with sizing. Its damage in houses, in addition to its injury to books, consists in causing the wall paper to scale off by its feeding on the starch paste. It occasionally gets into vegetable drugs or similar material left undisturbed for long periods. It is reported also to eat occasionally into carpets and plush-covered furniture, but this is open to question.

STRUCTURE AND RELATIONSHIPS.

The silverfish belongs to the lowest order of insects—the Thysanura—is wingless, and of very simple structure. It is a wormlike insect about one-third of an inch in length, tapering from near the head to the extremity of the body. The head carries two prominent antennæ, and at the tip of the body are three long, bristle-shaped appendages, one pointing directly backward and the other two extending out at a considerable angle. The entire surface of the body is covered with very minute scales like those of a moth. Six legs spring from the thorax, and, while not very long, they are powerful and enable the insect to run with great rapidity.

In certain peculiarities of structure, and also in their habits, these anomalous insects much remind one of roaches, and their quick, gliding movements and flattened bodies greatly heighten this resemblance. More striking than all, however, is the remarkable development of the coxæ or basal joints of the legs in the silverfish, which

[1] Hooke, R., Micrographia, p. 208–210. London, 1665.

finds its counterpart in roaches, and, taken in connection with the other features of resemblance, seems to point to a very close alliance between the two groups, if, indeed, the silverfish are not merely structurally degraded forms of roaches and to be properly classed with the Blattidæ.

ANOTHER COMMON SPECIES.

Another common silverfish of this country, referred to in the opening paragraph, has developed a novel habit of frequenting ovens and fireplaces, and seemingly revels in an amount of heat which would be fatal to most other insects. It disports itself in numbers about the openings of ranges and over the hot bricks and metal, manifesting a most surprising immunity from the effects of high temperature. This heat-loving or bakehouse species (fig. 2) was described in 1873 as *Lepisma domestica* by Packard, who reported it to be common about fireplaces at Salem, Mass. This species is also very abundant in Washington. What is evidently this same insect began to be noted commonly about 1895 in England and on the Continent, where it manifests the same liking for hot places exhibited by it in this country. The habit of this species of congregating in bakehouses and dwellings, about fireplaces and ovens, has given rise to the common appellation in England of "fire-brat." Similar descriptive names are applied to it also on the Continent. This species closely resembles the common silverfish in size and general appearance, but may be readily distinguished from it by the presence on the upper surface of dusky markings. It also possesses well-

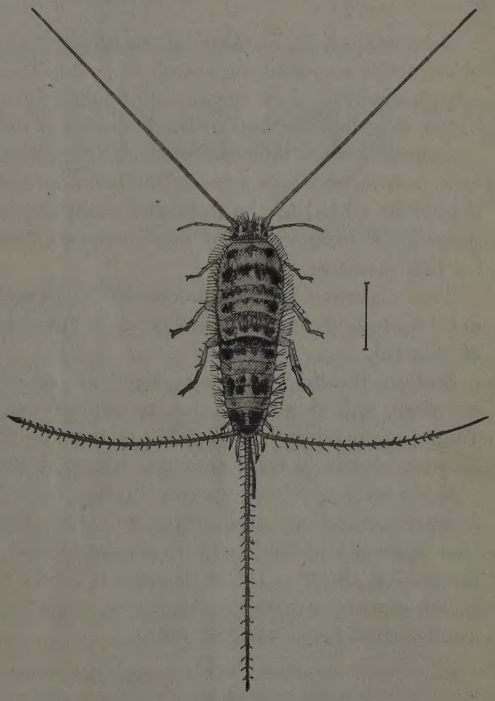

FIG. 2.—The "fire-brat" (*Thermobia domestica*): Adult female. Enlarged. (Original.)

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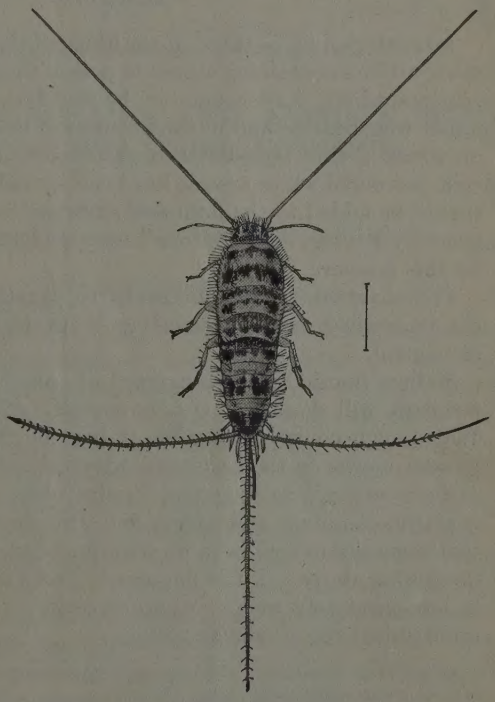

FIG. 2.—The "fire-brat" (*Thermobia domestica*): Adult female. Enlarged. (Original.)

marked structural differences, which have led to its late reference to a distinct genus—Thermobia. An Italian entomologist, Rovelli, has described this insect under the descriptive name *furnorum*, from its inhabiting ovens, and the name of the genus to which it is now assigned by English entomologists is also descriptive of its heat-loving character. A Dutch entomologist, Oudemans, reports that he has found it in abundance in all bakehouses that he has examined in Amsterdam, where it is well known to bakers and has received a number of familiar names.

REMEDIES.

Advantage may be taken of the liking of these insects for fabrics and other articles containing starch to poison them by slipping into all the crevices where they occur—in bookshelves and backs of mantels, under washboards, and in the bottoms of drawers—bits of cardboard on which a thin boiled starch paste poisoned with from 3 to 5 per cent powdered white arsenic has been spread and dried. The arsenic should be added to the flour and sufficient water used to make a thin paste by boiling. One of our correspondents reports complete relief by this measure.

The silverfish readily succumbs to pyrethrum, and wherever this can be applied, as on bookshelves, it furnishes one of the best means of control.

Sodium fluorid,[1] now recognized as one of the most efficient roach powders, will doubtless also be equally effective against silverfish. Where such course is possible it may be dusted by hand or with a powder blower in the situations where silverfish occur.

For starched clothing and similar objects liable to injury by it, frequent handling and airing and the destruction by hand of all specimens discovered is to be recommended, in addition to the remedies noted above. Little damage is likely to occur in houses except in comparatively moist situations or where stored objects remain undisturbed for a year or more.

[1] Marlatt, C. L. Cockroaches. U. S. Dept. Agr., Farmers' Bulletin 658, 15 p., 5 fig., 1915. Reference to sodium flourid against roaches, p. 12.

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F. C. BISHOPP
DALLAS, TEXAS

UNITED STATES DEPARTMENT OF AGRICULTURE

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WASHINGTON, D. C. 683 NOVEMBER 8, 1915.

Contribution from the Bureau of Entomology, L. O. Howard, Chief.

EXAMINED.

FLEAS AS PESTS TO MAN AND ANIMALS, WITH SUGGESTIONS FOR THEIR CONTROL.

By F. C. BISHOPP,
Entomological Assistant, Southern Field Crop Insect Investigations.

INTRODUCTION.

Fleas are of importance to man in two ways: First, as disease carriers and, second, as parasites or annoyers of man and animals. The dread disease of man known as bubonic plague has been found to be transmitted largely, if not entirely, through the agency of these insects. A disease known as infantile kala azar, occurring in the countries bordering the Mediterranean Sea, is probably also transmitted by them, and a species of tapeworm which infests dogs and occasionally people has been found to pass at least one stage in the dog flea, then gaining entrance to a new host by the swallowing of crushed or living fleas. As parasites of man and animals fleas are of considerable importance aside from disease transmission. In many instances they have been known to render houses uninhabitable for a time, and certain species cause considerable loss among poultry as well as annoyance to other animals.

LIFE HISTORY AND HABITS OF FLEAS.

It should be borne in mind that there are a great many different kinds of fleas. Most of these are of no importance to man, as they feed on various wild birds and mammals. Nearly all species have some one host upon which they prefer to live, but they may feed upon other animals and often thrive upon them.

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As examples may be cited the dog flea (fig. 1),[1] which normally feeds on dogs and cats, but which when excessively numerous may prove a troublesome pest to man. The human flea normally attacks man, but may be found on a number of other animals. Rat fleas, in the absence of their usual hosts, will bite man, and it is in this instance that fleas are responsible for the inoculation of man with bubonic plague.

There is a marked variation in the habits of fleas in regard to the intimacy with which they are associated with their hosts. Some kinds remain upon host animals practically all of the time. In fact, the chigoe flea normally buries itself in the skin of the host and there develops its eggs and dies. The sticktight flea, or chicken flea, has this habit of intimate association with the host, but does not bury itself in the flesh of the animal. Dog fleas ordinarily remain upon the domestic animals almost continuously throughout their existence, but are not attached, feeding only at intervals. The human flea has adapted itself to its host so closely that it remains upon man but little, being free the greater portion of the time.

There are four different stages in the life of fleas, as is the case with many other insects; these are the egg, larva, pupa, and adult.

A number of eggs are deposited by each adult flea. The egg laying, alternated with feeding, extends over a considerable period of time. In most cases the ova are deposited by the fleas while the latter are on the host, but as they usually are not cemented to the hair or feathers they fall out in the nest or resting place of the animal. The eggs are white or cream in color and ovoid in shape. Large numbers of them may often be seen on mats or cushions upon which infested dogs or cats sleep. Especially are they easily observed when on dark-colored cloths. The egg of the common dog flea is illustrated in figure 1 at *a*. Hatching usually takes place in from 2 to 12 days.

The larva when first hatched is very minute, of whitish color, and quite active. (See fig. 2, larva of European rat flea.) In this stage none of the fleas is parasitic. They depend upon various animal and vegetable débris, including the excrement of the adult fleas, for food. During their growth the skin is shed two or three times, and between four days and several months after hatching a silken cocoon is spun, and in this the larva transforms to the pupal or resting stage. (See fig. 1, *b* and *c*, pupa of dog flea.)

[1] The fleas mentioned in this bulletin are known scientifically as follows: Dog flea, *Ctenocephalus canis* Curtis; cat flea, *Ctenocephalus felis* Bouch.; human flea, *Pulex irritans* L.; rat fleas, *Xenopsylla cheopis* Roth. (the Indian rat flea), *Ceratophyllus fasciatus* Bosc. (the European rat flea), and others; chigoe, *Dermatophilus penetrans* L.; sticktight or chicken pox flea, *Echidnophaga gallinacea* Westw.

The insect remains within the cocoon for a period which may range from three days to more than a year. The cocoon of the dog flea is illustrated in figure 1 at *b*. The dark curved object within is the larva just before pupating.

The complete life cycle of members of this group of insects may be passed in as short a period as 19 days, but during cool weather

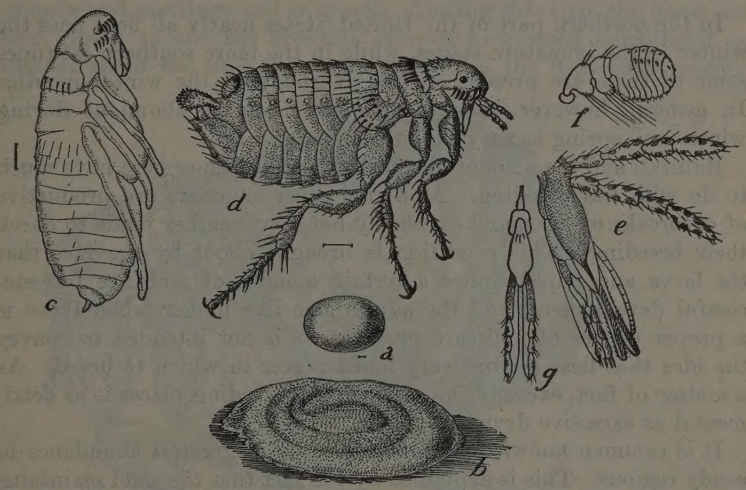

FIG. 1.—The dog flea: *a*, Egg; *b*, larva in cocoon; *c*, pupa; *d*, adult; *e*, mouth parts of same from side; *f*, antenna; *g*, labium from below. *b*, *c*, *d*, Much enlarged; *a*, *e*, *f*, *g*, more enlarged. (From Howard.)

or under adverse conditions the total period from egg to adult may extend considerably over a year.

HOW LONG THE ADULT WILL LIVE.

The length of life of the mature flea varies much in different species and also under different atmospheric conditions. During

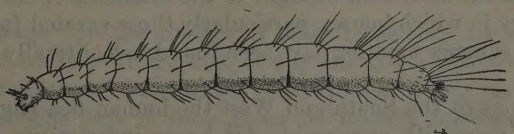

FIG. 2.—The European rat flea: Larva. Greatly enlarged. (Author's illustration.)

hot, dry weather, and when no animals upon which to feed are present, the duration of life is exeremtly short—two to five days When allowed to feed on blood, which is the only food taken by the adults, they may live from a month to almost a year. During sum-

mer probably the average longevity of the human flea without food is about two months, of the dog flea somewhat less, and of the stick-tight flea still less.

ABUNDANCE OF FLEAS IN RELATION TO SEASON, CLIMATE, AND OTHER CONDITIONS.

In the northern part of the United States nearly all fleas pass the winter in the immature stages, while in the more southern latitudes some of them are present on hosts throughout the winter months. In general, however, these insects are never as abundant during winter and spring as they are in summer and fall.

Rainfall and the amount of moisture in the atmosphere have much to do with flea breeding. As a rule rainy summers are productive of outbreaks of fleas, and extremely hot, dry weather tends to check their breeding. This condition is brought about by the fact that the larva and pupa require a certain amount of moisture for successful development, and the adults also live longer when there is a proper degree of moisture present. It is not intended to convey the idea that fleas require very moist places in which to breed. As a matter of fact, excessive moisture in the breeding places is as detrimental as excessive dryness.

It is common knowledge that fleas occur in greatest abundance in sandy regions. This is explained by the fact that the sand maintains a more uniform moisture condition and thus permits the immature stages of the flea to develop with greater success. The sand also offers some protection to the adults and renders heavy rains less destructive to all stages of the flea present on the soil.

FLEAS AS PESTS IN THE HOUSEHOLD.

As has been pointed out,[1] in the eastern part of the United States the dog flea is the species of greatest importance as a household pest. Many instances have been brought to the attention of the Bureau of Entomology in which houses, particularly those vacated for some time during the summer months, have been found to be literally overrun by these pests.

In portions of the South and West the human flea (figs. 3 and 4) is the one primarily responsible for house infestations. Although the host relationship of these two species is somewhat different, the same methods of control are applicable, for the most part, to both.

[1] Howard, L. O. House Fleas. U. S. Dept. Agr., Bur. Ent., Cir. 108, 4 p., 2 fig., Feb. 11, 1909.

The conditions which give rise to outbreaks in houses, particularly in the case of the dog flea, are usually these: Pet dogs or cats are kept about the household during the spring and early summer, and great numbers of eggs are deposited upon them by the fleas. These eggs are scattered about the floors and soon hatch into minute maggots which feed upon the vegetable and animal matter under carpets and mattings and in cracks. During this time the house has been closed up and the breeding allowed to proceed unmolested, so that at about the time the occupants return the fleas have reached

FIG. 3.—The human flea: Adult female. Greatly enlarged. (Author's illustration.)

the adult stage. In the absence of other hosts they are exceedingly hungry and ready to attack man or any animals which are accessible.

Some infestations of residences come from breeding places beneath the houses. The fleas in these cases are usually furnished by stray animals which sleep under the buildings. The immature stages develop in the accumulation of dust and vegetable matter in the beds of these animals. Instances are not uncommon where such infestations may extend to lawns, barnyards, and, in fact, all over the premises, although as a rule the center of infestation is in some one definite place frequented by animals.

The infestations of the human flea are usually less heavy than in the extreme cases above mentioned, and the breeding places are often more widely extended.

A number of instances in the Southern and Central-Western States have come to notice where hogs appear to have been the source of gross infestations of the human flea. The adult fleas feed on the hogs, and breeding takes place in the beds of these animals. In some

FIG. 4.—The human flea: Adult male. Greatly enlarged. Note the difference in the shape of the abdomen of the male as compared with that of the female (fig. 3). (Author's illustration.)

instances the source of infestation is in the hog runs, but more usually it is derived from hogs sleeping under houses.

FLEAS INJURIOUS TO POULTRY AND DOMESTIC ANIMALS.

Fortunately the higher domestic animals are comparatively free from flea attacks. Horses, cattle, sheep, and goats are very seldom annoyed, although a few instances have come to our attention in which the sticktight flea infested horses. Hogs are infested to some extent, but seldom heavily enough to do any damage.

THE STICKTIGHT FLEA.

The sticktight flea, or southern chicken flea, is probably the most important of our live-stock infesting species. This form attacks a number of different hosts, including poultry, dogs, cats, and some wild animals. As has been stated, the adult fleas remain during the greater part of their lives attached to the host animal. On dogs and cats they are largely found on the ears, particularly along the edges. In the case of poultry infestations fleas are most common on the heads of the hosts, where they are to be seen in groups or patches. This habit of attaching in clusters seems to be well marked, and an infested fowl often may be recognized at a considerable distance by the dark flea-covered areas about the eyes, comb, and wattles. Figure 5 illustrates the usual mode of infestation on a chicken's head, and figure 6 shows one of the fleas much enlarged. When the fleas are excessively abundant they may be found in similar patches on the neck and various parts of the body.

FIG. 5.—Head of rooster infested with the sticktight flea. Somewhat reduced. (Author's illustration.)

FIG. 6.—The sticktight flea: Adult female. Much enlarged. (Author's illustration.)

This flea is most common and of greatest importance in the Southern and Southwestern States. It has been reported as injurious to poultry as far north as Kansas. The injury is most marked in young chickens, which when fairly heavily infested often die

quickly. Older fowls are more resistant, but have been known to succumb to very heavy infestations; and certainly the fleas materially reduce egg production, retard the growth of fowls, and diminish their size.

The eggs are deposited by the adult flea while it is attached to the host. They fall to the ground under the roost in chicken houses or under sheds frequented by the poultry and there continue to develop. When dogs and cats are infested the immature stages develop largely in the material used by them for beds.

A few other species of fleas are occasionally found in poultry houses. Some of these may be normally bird-infesting species, while others are at home in the houses of domestic poultry. Infestations by these fleas have been reported from several places in the Northern States, particularly in the Northwest. The presence of the fleas is usually first detected by the adults getting on the bodies of persons entering chicken houses. These fleas do not remain attached to the host continuously as does the sticktight flea. They are seldom of any great importance and may be controlled by the same methods outlined on pages 13 and 14.

DOG AND CAT FLEAS.

Dogs and cats are infested by two very closely related species of fleas,[1] and these appear to feed more or less interchangeably on the two hosts, as well as occasionally on man and other animals. While they cause these hosts much annoyance and, as has been pointed out, are also responsible for the infestation of dogs by tapeworms, serious injury seems to be rare. However, in the case of valuable dogs and cats it is often desirable to rid them of fleas, and in all cases where these animals are closely associated with man the control of the fleas upon them is of importance. As will be seen by comparing figure 1 with figure 6, the dog flea is quite different from the sticktight flea in structure as well as in size. The adults do not remain attached to the host in one place, but the life history is not vastly different from that of the sticktight flea. Breeding takes place in similar materials in situations occupied by the host animals. Mr. Theodore Pergande, working with the dog flea at Washington, D. C., found the life cycle from egg to adult to be completed within 17 to 37 days. It is thus seen that a great number of fleas might be bred in and beneath an unoccupied house in a comparatively short period.

Both of these species have a very wide distribution, being found in practically all parts of the world where dogs and cats are found.

[1] The cat flea is known scientifically as *Ctenocephalus felis* Bouché, and the dog flea as *Ctenocephalus canis* Curtis. The human flea also is not uncommonly found on dogs and cats.

FLEAS IN RELATION TO BUBONIC PLAGUE.

During recent years bubonic plague has been introduced into the United States on both the Pacific and Gulf coasts. The infestation in California persisted for a number of years, although it was closely held in check through the efforts of the Public Health Service and the State board of health. The disease around San Francisco not only persisted among the rats, but gained a foothold among ground squirrels in the counties adjacent to San Francisco Bay. A strenuous fight is being waged against rats in all of the Pacific ports and against ground squirrels in the territory where the disease has become established among these rodents.

During the year 1914 the disease broke out in New Orleans, but strict quarantine measures and an energetic campaign against the rats kept the malady from spreading and limited the number of human cases.

While the plague situation is now well in hand it is important that all have a general knowledge of the essential steps in controlling the disease. The prevention of the introduction of bubonic plague depends to a considerable extent upon quarantine regulations at our ports of entry, but it is of even greater importance that united effort be put forth to control the rats in the seaport towns. The work should not stop here, as it is of importance that concerted action be taken against rats and ground squirrels throughout the entire country.

It may be gathered from what has been said that the control of bubonic plague depends almost entirely upon the destruction of the rat population. This is essential in that the disease always starts by gaining a foothold among the rats, and as these animals die and the fleas leave them and attack man the human cases of plague begin.

In addition to the importance of rat control from the standpoint of disease prevention there is every reason to wage war against these pests on account of their importance as destroyers of agricultural and other products. It has been estimated that the loss in the United States due to rats exceeds $100,000,000 annually. The principal methods of combating these rodents[1] are rat proofing, trapping, poisoning, and destruction by natural enemies.

With the reduction in numbers of rats and mice the various species of fleas which infest them and which in turn may play a part in carrying bubonic plague are greatly reduced in numbers. The cleaning up of the breeding places of rats and the destruction of their nests will also accomplish the extermination of a large number of fleas in the immature stages. Some of the methods of trapping fleas mentioned under "Means of Repression" will aid in destroying those

[1] The methods of rat control are discussed in Farmers' Bulletin 369, U. S. Department of Agriculture, by Mr. D. E. Lantz, of the Bureau of Biological Survey.

which may have fed on rats and are therefore dangerous as regards disease transmission.

Persons resident in districts where plague occurs among the ground squirrels should remember that there is danger of infection from the bites of fleas which infest these animals.

MEANS OF REPRESSION.

Certain general principles regarding the control of fleas are applicable to nearly all species, but some modifications of the methods employed are necessary for different species and under the different conditions in which they exist.

METHODS OF COMBATING HOUSEHOLD INFESTATIONS.

As has been pointed out, the dog flea and the human flea are the two most important species invading the habitations of man. It has also been suggested that the adult fleas feed more or less on cats and dogs and that the immature stages develop in the cracks of floors and beneath houses. It is at once apparent that two steps are necessary to cope with the pest: (1) The destruction on the host of the adults which are producing the eggs, and (2) the clearing out of the immature stages which are breeding in or under the house.

THE DESTRUCTION OF FLEAS ON CATS, DOGS, AND HOGS.

One of the most successful methods of killing fleas on cats and dogs is to wash the animals thoroughly in a tub containing the proper proportion of a saponified coal-tar creosote preparation, of which there are a number on the market, known as "stock dips," etc. The animal should be thoroughly scrubbed, making sure that the fleas on the head are well soaked, as many rush there to get away from the parts that are covered with the solution. After the animal has been in the bath for about 5 or 10 minutes it may be removed and allowed to dry. In the case of cats, especially if tender skinned, the preparation may be washed out of the fur with soap and warm water soon after the animal is taken out of the solution.

In addition to the destruction of all fleas present, this accomplishes the cleansing and deodorizing of the fur and also aids in the healing of any wounds which are present.

Other methods of destroying fleas on cats and dogs have been recommended. Among these the careful rubbing into the hair of powdered naphthalene or moth balls has been found effective. Pyrethrum or Persian insect powder is used in the same way. Both of these materials stupefy the insects and cause them to come to the

surface of the hair or actually drop out. The animals should be treated on papers spread on the floor and the insects burned after the dusting is completed.

Fleas on hogs may be destroyed by dipping the animals in a vat containing some of the creosote dips as used for the hog louse or by sprinkling crude petroleum on them when they are eating.

CONTROL OF HOSTS.

In order to avoid the infestation of houses, it is important to keep all animals from beneath dwellings. In such situations breeding may progress rapidly, and it is very difficult to treat the breeding places. If fleas are continuously annoying about the household, it is often desirable not to admit cats and dogs at all, but to provide regular sleeping quarters for these animals out of doors and prevent flea breeding by methods suggested in the following paragraph. Stray cats and dogs should not be encouraged about the premises. In towns and cities the enforcement of the dog-tax law and the destruction of all untagged animals will tend greatly to reduce house infestations. It is also desirable to keep different kinds of animals which are subject to flea infestation separated, and care should be exercised that infested animals are not brought to clean premises and that infested poultry are not placed with a clean flock.

DESTRUCTION OF FLEAS IN IMMATURE STAGES.

Following the ridding of infested animals of adult fleas, it is important to destroy the immature ones which are constantly becoming full grown and reinfesting animals and annoying man. In household infestations it is usually found that the breeding takes place in the cracks of floors or beneath carpets or in rooms which are not frequently swept, but which may be visited by pet dogs and cats. The carpets and rugs should be removed, the floors thoroughly swept, and all of the dust thus obtained burned, as it contains many of the eggs and maggots of the fleas. The floor should then be scrubbed with strong soapsuds or sprinkled with gasoline, taking care to avoid having fires about during this procedure. After the floor coverings are thoroughly aired and beaten they may be returned, but it is desirable before putting them down to sprinkle the floor with naphthalene crystals or pyrethrum powder.

In flea-infested regions it is advisable to avoid the use of mattings and carpets. These may be supplanted by rugs or oiled bare floors. This permits frequent sweeping of the floors and makes the destruction of the immature stages easier if an infestation becomes established.

Among other methods for destroying the fleas in houses the following have been tried and recommended: Scatter 5 pounds of flake naphthalene over the floor of an infested room and close tightly the doors and windows for 24 hours. After this time the naphthalene may be swept into another room, and so on, thus making the treatment inexpensive. The free use of alum, both in the powdered form sprinkled over carpets and rugs and by dipping papers in an alum solution and placing them under the rugs, is said to give satisfactory results. The fumigation of houses with sulphur fumes or hydrocyanic-acid gas also accomplishes complete destruction. In addition to killing all of the fleas, rats and mice are destroyed by these last-mentioned methods. In using sulphur the infested building should be closed up tightly and the material used at the rate of 4 pounds to each 1,000 cubic feet of space. If the immature stages have been destroyed by the methods mentioned above, 2 to 3 pounds of sulphur per 1,000 cubic feet of space will be sufficient to destroy the adults. The sulphur is made into a cone shape in a good-sized pan or kettle and placed in a larger pan containing water to avoid danger of fire from the heat generated. A little alcohol is then poured into a depression made in the top of the cone of sulphur, and a match applied. Each room should have a pan of sulphur, and the rooms should be kept closed about 12 hours. As the gas generated corrodes metals and injures plants, it is necessary to remove metal objects and potted plants before fumigating. It is not advisable for anyone to undertake the use of hydrocyanic-acid gas without obtaining the complete directions for its employment as outlined in Farmers' Bulletin 699, entitled "Hydrocyanic-Acid Gas Against Household Insects." This gas is very poisonous, but is one of the most satisfactory for destroying all sorts of vermin in buildings.

When house infestations are derived from fleas which breed beneath or around houses the first step is to clean out all the loose material in which fleas may be breeding and burn it, and then to use crude petroleum freely about the breeding places. This may be followed by scattering common salt about and thoroughly wetting it down. The free use of lime on the cleaned areas also apparently destroys many immature fleas. In exceptional cases lawns become infested, and fleas breed out around the roots of the grass. It is impracticable to apply chemicals in such situations, but much may be done to check the breeding by cutting the grass exceedingly short and thus exposing the young fleas to the heat of the sun, which will usually accomplish their destruction. In certain sections it has been found feasible to destroy flea infestations in barns and hog runs by diking the infested areas and pumping water in so as to flood them entirely.

TRAPPING.

Following the treatment of host animals and the thorough cleaning up of the premises, as has been outlined, many of the remaining adult fleas may be caught by the use of traps.

There seems to be some virtue in the use of lights at night for attracting the adult fleas. A small lamp set in a pan of water covered with a film of kerosene may be used for this purpose.

It has been found that a considerable number of fleas may be collected about a room or cellar by allowing an animal such as a guinea pig or cat to be free in the room. The fleas thus concentrated on the animal may be destroyed by the methods mentioned under "The destruction of fleas on cats, dogs, and hogs." In districts where the plague is known to exist and it is desirable to catch the few fleas which may be about the premises, this method is of some value.

ISOLATING AND REPELLING.

It has been determined that the greatest horizontal distance fleas can jump is about 13 inches, and they can not jump more than one-half of this distance vertically. It is therefore possible to prevent them from gaining access to a bed by placing sticky fly paper about 13 inches wide on the floor around the bed, provided fleas are not breeding out under it. By keeping the bedding from reaching near the floor it is also possible to keep fleas out by placing the legs of the bed in a pan of water covered with a film of kerosene.

Many different substances have been advocated as repellents for fleas. Among these may be mentioned such plants as pennyroyal, and boughs and chips of pine. Naphthalene crystals and pyrethrum have also been employed for dusting between the sheets in order to repel the fleas from bedding, and these substances, as well as oil of pennyroyal and oil of tar, may be used about the household to drive out the fleas.

It should be borne in mind that the methods of trapping and repelling just discussed are only secondary to the more important measures of destroying the breeding places and freeing hosts from fleas.

METHODS OF CONTROLLING THE STICKTIGHT OR CHICKEN FLEA.

Many of the suggestions for controlling fleas in the household are applicable to the sticktight flea. As has been pointed out, this species breeds largely in chicken houses and adjacent buildings frequented by the fowls, although dogs and cats may be important sources of infestation.

As a preliminary step it is well to see that the poultry are kept away from other animals as far as possible. Especial care should be exercised to keep dogs and cats from lying about the chicken yards or places frequented by the poultry. All animals, and the poultry as well, should be excluded from beneath houses and barns, as such places are favorable for flea development and difficult to treat if they become infested. These precautions should be followed by a thorough cleaning out of the chicken house and outbuildings frequented by the poultry. All of the material should be hauled to a good distance from the buildings and scattered out. The places where the fleas are thought to be breeding should then be sprinkled with crude oil. One of the most satisfactory methods of preventing breeding is to scatter salt freely about the chicken house and then wet the soil down thoroughly. This species can not thrive in damp places, and if the sprinkling is done two or three times a week no further breeding is possible. If salt is used, due care should be taken to prevent the fowls from devouring it on account of its poisonous qualities.

It is rather difficult to destroy the sticktights on the poultry without injuring the host. It is desirable, however, in the case of heavy infestations to destroy as many of the fleas as possible. This may be accomplished by carefully applying carbolated vaseline to the clusters of fleas on the fowls or greasing them with kerosene and lard—one part kerosene to two parts lard. In all cases care should be taken when applications are made not to get the material on the poultry except on the seat of infestation. It is important that dogs and cats be freed from sticktight fleas. This may be accomplished by washing them in a saponified coal-tar creosote preparation, as has been described, or many of the insects may be killed by greasing the most heavily infested parts with kerosene and lard. Rats sometimes harbor these fleas in considerable numbers, therefore their destruction will aid in the control work as well as do away with another troublesome chicken pest.

The thorough cleansing of poultry houses and runs and the application of crude petroleum will be found to aid in the control of other important enemies of fowls, such as mites and chicken ticks or "blue bugs."

TREATMENT OF FLEABITES.

In regions in the United States where the plague is not known to occur no special concern need be felt regarding fleabites. When feeding, the fleas inject a salivary secretion which tends to produce inflammation at the site of the puncture. Usually the bites result in small inflamed spots, but occasionally, where the pests are very numerous and in cases where individuals are susceptible to the effect

of the bites, more general inflammation may occur, sometimes followed by swelling and occasionally, especially after scratching, by ulceration.

Those who are especially annoyed by the bites will find that various cooling applications will give relief. A 3 per cent solution of carbolic acid in water applied to the bites will be beneficial, and such substances as menthol, camphor, and carbolated vaseline will be found to allay the irritation. Iodine in the form of a tincture, if applied to the bites, will alleviate the irritation, but should not be used by persons afflicted with any form of eczema or applied to the tender skin of young children, as it may stimulate the eczemic eruptions or blister the skin, causing undue annoyance.

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